# PATENT SPECIFICATION

**756,111**

*Date of Application and filing Complete Specification August 5, 1954.* *No. 22802/54*

*Application made in France on August 11, 1953.*

*Complete Specification Published: August 29, 1956.*

Index at acceptance:—**Class 4**, G4, G8(B5: C), G8F(1; 4), G8K.

## COMPLETE SPECIFICATION

## "Improvements in Retractable Landing Gears for Aircraft".

We, MORANE-SAULNIER, of 3/5 Rue Volta, Puteaux, Seine, France, a Corporate Body organised under the Laws of France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to retractable landing gears for aircraft of the type in which a landing wheel is carried by a strut pivotally mounted on the aircraft structure, means being provided to rotate said strut around its axis, whereby the wheel can be steered when the aircraft is rolling on the ground.

Such steerable wheels are in particular used on aircraft equipped with so-called tricycle landing gear.

The main difficulty in manufacturing a landing gear of this type is to ensure the proper steering transmission without interfering with the retraction and vice versa.

Devices have already been proposed in which the steering transmission is established between the steering control means and the strut on which the wheel is mounted only when said strut is brought into the landing position, while in the retracting and retracted positions of the strut the transmission is disconnected.

However, it has been difficult to obtain complete security in establishing in a simple and economical way the necessary non-permanent connections.

The present invention has for its main object to design a retractable landing gear carrying an orientable wheel in which a permanent steering transmission is established in a reliable way between the steering control means and the strut without interfering with the pivotal displacement of the strut in retraction and extension.

Another object of the invention is to provide steering transmission means capable of being automatically disengaged and re-established when the landing wheel is in contact with the ground.

According to this invention a retractable landing gear for aircraft comprises a landing-wheel-carrying strut rotatably mounted for steering in a bearing of a strut-housing which is pivotally mounted for retraction about a shaft fixed to the aircraft structure, the axis of said shaft being perpendicular to the axis of the strut-bearing, a spur pinion or spur-toothed sector fast on the strut and co-axial with the bearing axis, and a tubular rack slidable on the shaft by steering control means and having teeth, which mesh with the teeth of said pinion or sector and extend circumferentially of the tubular rack through an arc not less than the range of angular displacement of the strut-housing about the shaft, so as to remain in mesh whatever the position of the strut-housing.

Preferably, means are also included for automatically disengaging the steering transmission when the ground reaction causes the landing wheel to be angularly displaced beyond the limits of a predetermined steering lock.

In a preferred form of construction embodying the feature described in the preceding paragraph hereof, the pinion or toothed sector is formed on a collar rotatable by the strut through an internal and external tooth coupling, which is disengageable by axial displacement of the collar, effected by cam and follower means against the action of a spring or like resilient means when the collar is rotated relatively to the strut-housing beyond the limits of a predetermined steering lock.

The invention will be more fully understood from the following description with reference to the accompanying drawings of a typical embodiment, given by way of example only, the scope of the invention being defined in the appended claims.

*(Price 3/-).*

In the drawings:

Figure 1 shows a landing gear in side elevation, partly in section;

Figure 2 is an axial cross section of a part of the same on a larger scale;

Figure 3 is an elevation, partly in section, of the upper part of the landing gear;

Figure 4 is a plan view corresponding to Figure 3; and

Figure 5 is a perspective, somewhat schematic, view of the landing gear.

Referring to the drawings, an orientable wheel 1 of a retractable landing gear is mounted on the extremity of a lever 2, the other extremity of which is pivoted about an axle 3 carried by the lower extremity of a strut 4. Strut 4 is rotatively mounted in a strut-housing 5 through a thrust ball bearing 6 and another ball bearing 7.

The inner race of the bearing 7 is secured on the extremity of strut 4 by an annular element 8 secured by a nut 9 on the threaded upper extremity of the strut 4.

The housing 5 is pivoted by means of lugs 12 and 13 on pivots 14 and 15 carried by the aircraft structure. The pivoting of said supporting member 5 enables the strut 4 to be brought either into the landing position shown in Figures 1 and 5 or into the retracted position shown in dot-and-dash lines on the same figures.

It must be understood that the retracting displacement can be obtained in any conventional way, for instance by a jack one extremity of which is connected to the aircraft structure, while the other is pivoted to an arm 17 rigid with the supporting member 5 and provided at its end with a pivot bearing 16.

The wheel 1 is elastically supported by the strut 4 through a shock absorber 18 one extremity of which is pivoted on an extension 19 of the arm 2 while the other is pivoted on an axle 20 carried by the upper part of the strut 4.

The steering wheel 1 is obtained by the rotation of the strut 4 around its axle. It is ensured by a device comprising the annular element 8 which is connected to the strut 4 by a splined joint 22 and a collar 23 provided with internal teeth 24 meshing with corresponding teeth formed on the outer surface of the element 8 and comprising furthermore spur gear teeth 25 forming a pinion, or rather in the illustrated example a toothed sector, meshing with a cylindrical rack 26. Rack 26 is formed on a tubular element 27 slidably mounted, for example through balls 28, on a shaft 29 the extremities of which are fixedly mounted in the pivotal supports 14 and 15 through screws 32.

The axial displacements of the tubular element 27 to steer the wheel 1 are ensured by a control rod 33 through a lever 34-35, keyed on a pivot 36 rotatably mounted in a supporting member 37 carried by the aircraft structure. The extremity of the arm 35 of said lever is connected, through a link 38, to a radial extension 39 of the tubular element 27. Now, to obtain automatic disengagement of the steering transmission when the wheel is urged by ground reactions to rotate beyond the limits of the required steering lock, e.g. when the aircraft is towed or rolls on an uneven ground, the collar 23 is axially displaceable under the action of resilient and cam means. In a preferred embodiment the annular element 23 is urged by a spring 46 against two rollers, constituted by the outer races 42 of two ball-bearings, the inner races 43 of which are rigidly secured by bolts 44 to brackets mounted on the upper part of the housing 5. The collar 23 is provided with a cam surface 45 extending along an arc corresponding to the permitted steering lock of the wheel strut 4. When the angular displacement of the collar 23 exceeds this arc, collar 23 is axially displaced by the cam-follower rollers acting on the cam 45. This axial displacement of the annular member 23 brings the teeth 24 out of mesh with the corresponding teeth of the annular member 8 so that the steering transmission is automatically disengaged. The mechanism above described is protected against penetration of dust and the like by means of two telescopic members 47 and 48.

It must be understood that any conventional means may be provided between rack 26 and the steering control means to disengage the steering connection at will.

It will be understood that the teeth 26 do not necessarily extend along a complete circumference. The minimum angle along which the teeth must extend is about 90 degrees, corresponding to the angular displacement of the strut. However, to increase the mechanical resistance of the teeth, permitting them to transmit the necessary forces for steering, said teeth are preferably extended beyond the 90 degrees above mentioned. In Figure 2, these teeth extend substantially along one half of a circumference.

To close completely the opening in which the landing gear is retracted, there are three panels, viz. a panel 52 pivoted about an axis 53 perpendicular to the vertical plane of symmetry of the aircraft and connected by a link 54 to the housing 5 and two other panels 55, one of which is visible in Figure 1, pivoted about horizontal axes, not shown, in a plane parallel to the vertical plane of symmetry of the aircraft.

The operation of the illustrated landing gear is as follows:

When the strut 4 is brought into its landing position, as shown in full lines on the drawings, the axis of orientation of the

wheel 1 is substantially vertical. To steer the aircraft on the ground by orienting the wheel 1, the pilot operates the control rod 33. Rod 33 can for instance be connected to a rudder-bar when the landing gear is lowered, this connection being established directly or through a servo-mechanism.

If the rod 33 is displaced in the direction of the arrow F of Figure 4, the lever 34-35 is rotated about its axis 36 clockwise, so that the rack 26 is displaced from the right to the left as seen in Figure 4, while the displacement of the rod 33 in the opposite direction causes a displacement of the rack 26 in the opposite direction. The pinion 25, constantly in mesh with the teeth of the rack 26, is thus rotated in the corresponding direction, such rotation being transmitted to the collar 23 and annular member 8 and thus to the strut 4 carrying the wheel 1.

When the landing gear is retracted, the pinion 25 revolves around the axis of the cylindrical rack 26 meshing with the same in every angular position of the strut 4. Due to the fact that the teeth 26 have their planes of symmetry perpendicular to the axis of the shaft 29, the pivoting of the strut 4 does not cause any rotation of the strut with respect to the housing 5.

It is clear from this description, that the landing gear according to the invention ensures perfect security due to its simplicity and to the permanent meshing of the teeth of the pinion, as well in the landing as in the retracted position of the strut 4.

The panels 52 and 55 are automatically operated in the usual way, the panel 52 through the link 54 connected to the landing gear and the panels 55 by any conventional device.

What we claim is:—

1. A retractable landing gear for aircraft comprising a landing-wheel-carrying strut rotatably mounted for steering in a bearing of a strut-housing which is pivotally mounted for retraction about a shaft fixed to the aircraft structure, the axis of said shaft being perpendicular to the axis of the strut-bearing, a spur pinion or spur-toothed sector fast on the strut and co-axial with the bearing axis, and a tubular rack slidable on the shaft by steering control means and having teeth, which mesh with the teeth of said pinion or sector and extend circumferentially of the tubular rack through an arc not less than the range of angular displacement of the strut-housing about the shaft, so as to remain in mesh whatever the position of the strut-housing.

2. A retractable landing gear for aircraft as claimed in Claim 1, further comprising means for automatically disengaging the steering transmission when the ground reaction causes the landing wheel to be angularly displaced beyond the limits of a predetermined steering lock.

3. A retractable landing gear for aircraft as claimed in Claim 2, in which the pinion or toothed sector is formed on a collar rotatable by the strut through an internal and external tooth coupling, which is disengageable by axial displacement of the collar, effected by cam and follower means against the action of a spring or like resilient means when the collar is rotated relatively to the strut-housing beyond the limits of a predetermined steering lock.

4. A retractable landing gear for aircraft constructed, arranged and operating substantially as herein described and as illustrated in the accompanying drawings.

For the Applicants,
TONGUE & BIRKBECK,
Bank Chambers, 329, High Holborn,
London, W.C.1,
Chartered Patent Agents.

Printed for Her Majesty's Stationery Office by Maximus Printing Company, Portsmouth. 335/3.—1956.
Published at the Patent Office, 25, Southampton Buildings, London W.C.2, from which copies may be obtained.

756,111 COMPLETE SPECIFICATION
3 SHEETS

*This drawing is a reproduction of the Original on a reduced scale.*
*SHEET 1*

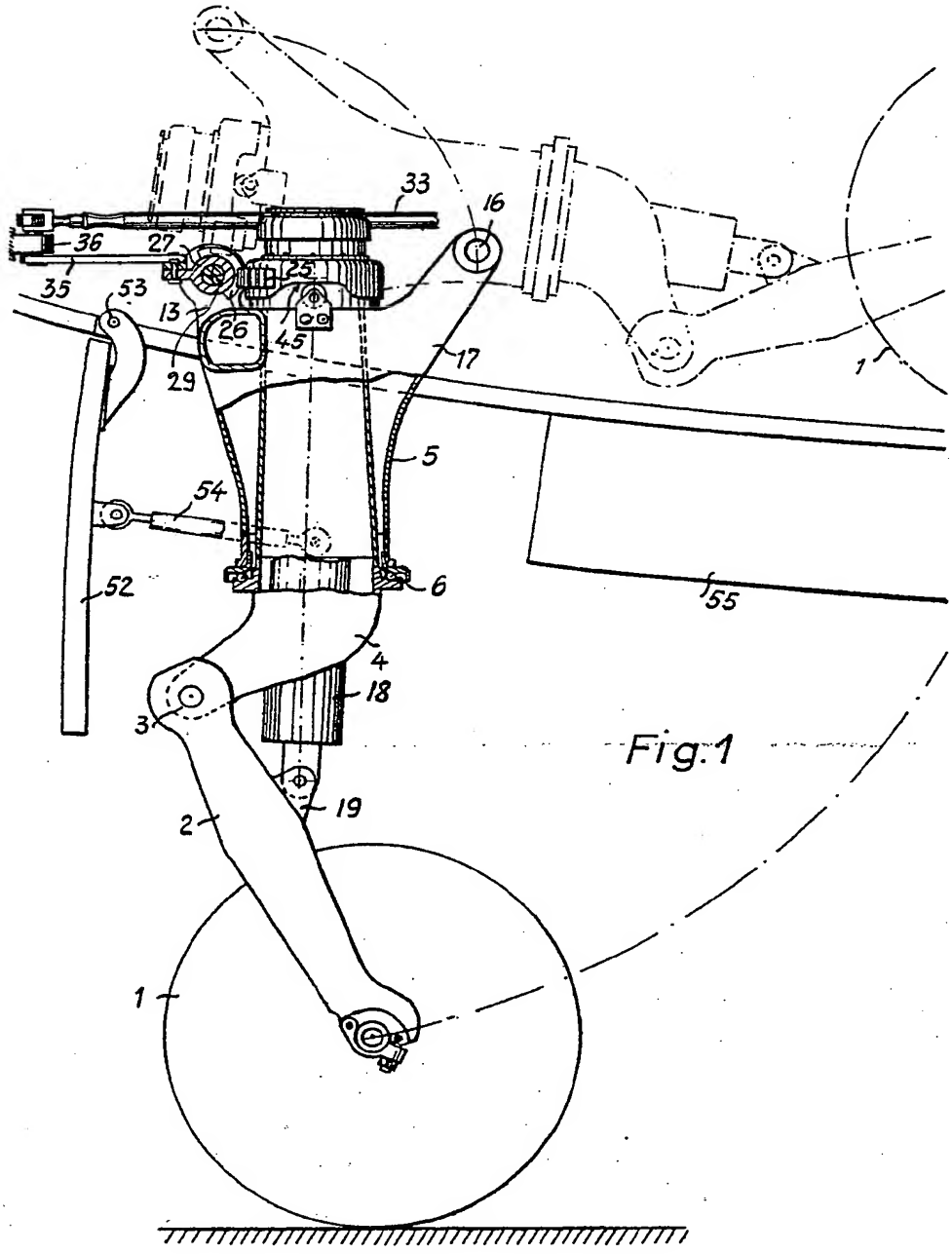


Fig.1

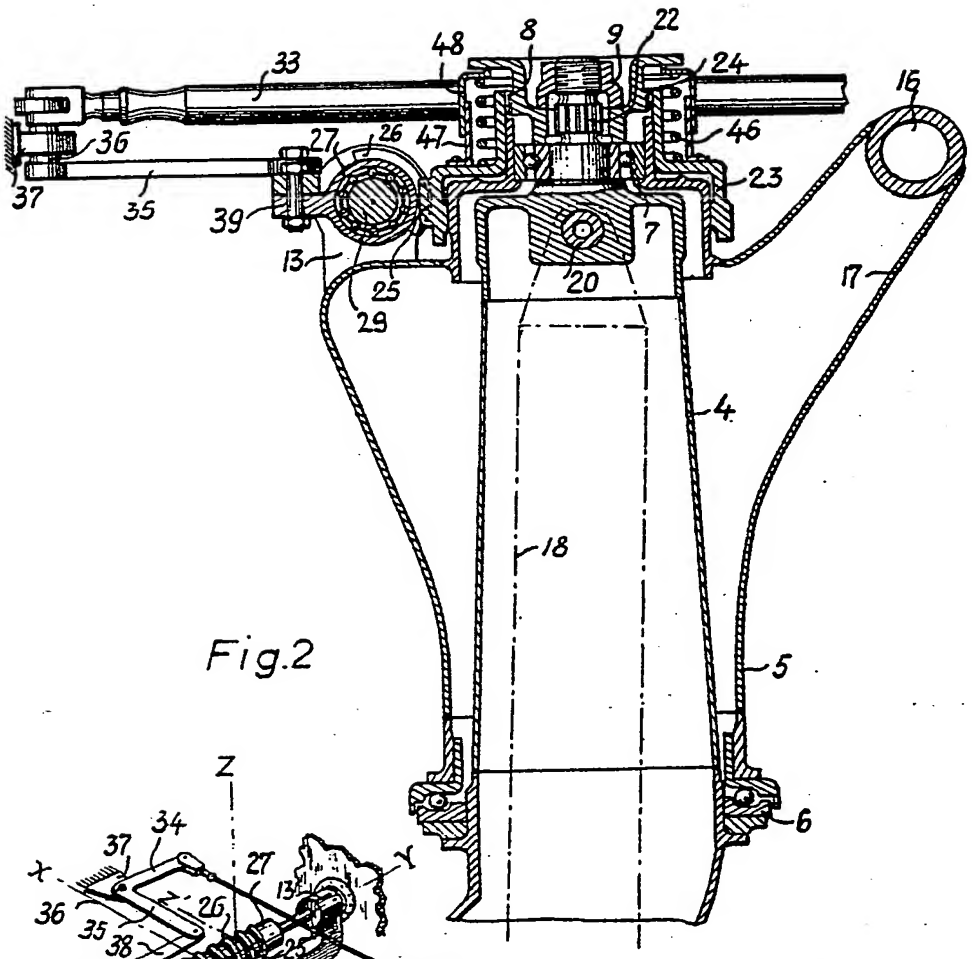
48
8
9
22
24
33
16
36
27
26
47
46
37
35
39
23
7
13
25
20
17
29
4
18
5
6

Fig.2

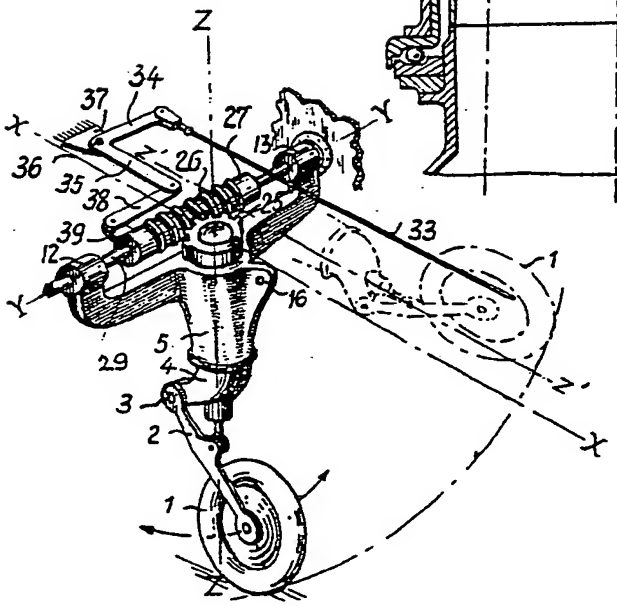
Z
34
37
27
X
Y
36
26
13
35
38
25
39
33
12
1
16
5
29
4
3
2
1
Z'
X
Z

Fig.5

756,111 COMPLETE SPECIFICATION
3 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEETS 2 & 3


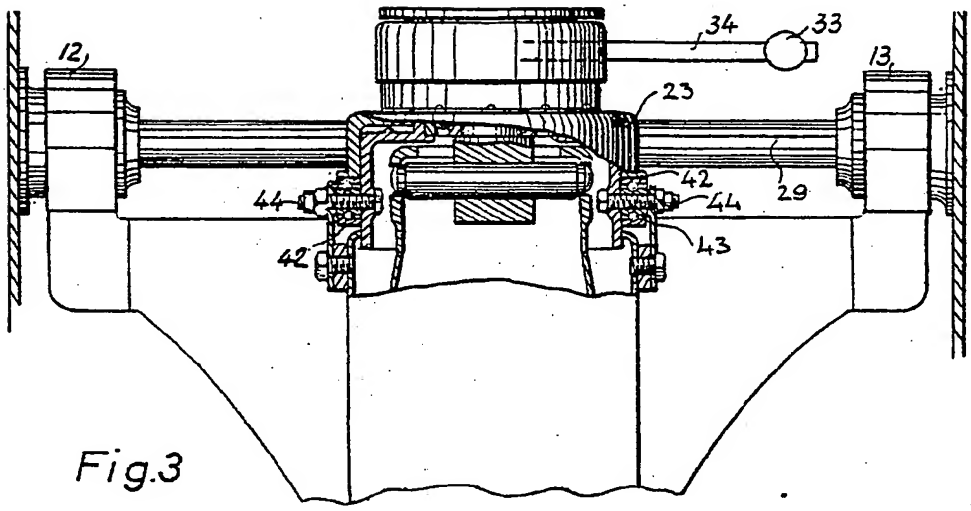


Fig.3

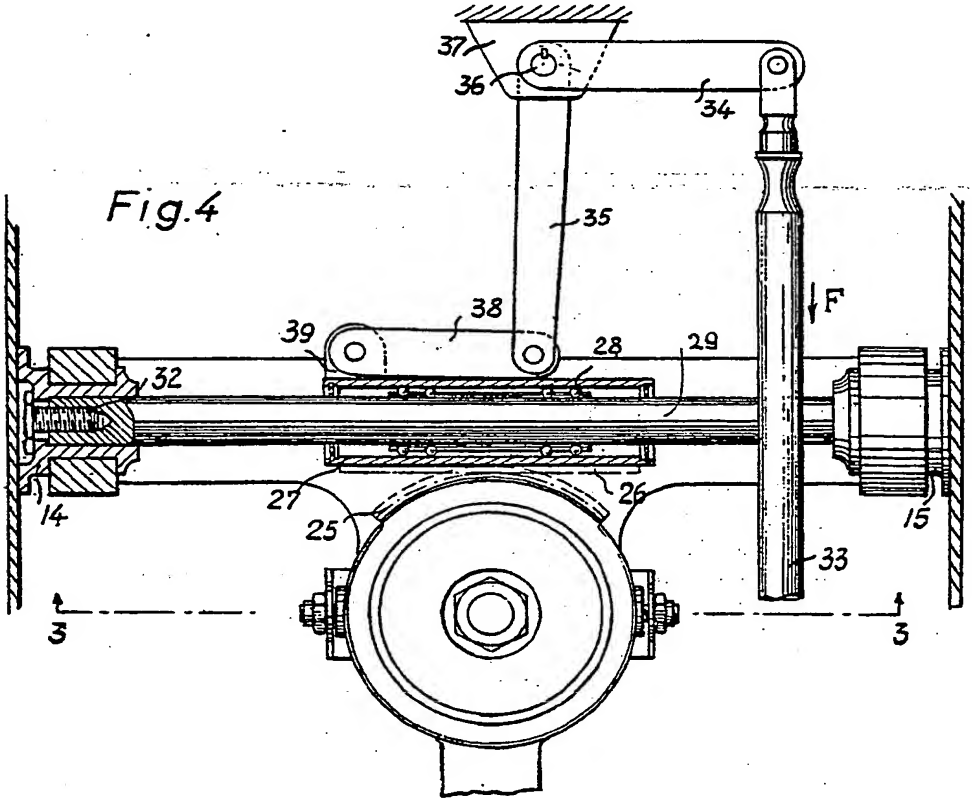


Fig.4

756,111 COMPLETE SPECIFICATION
3 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEETS 2 & 3

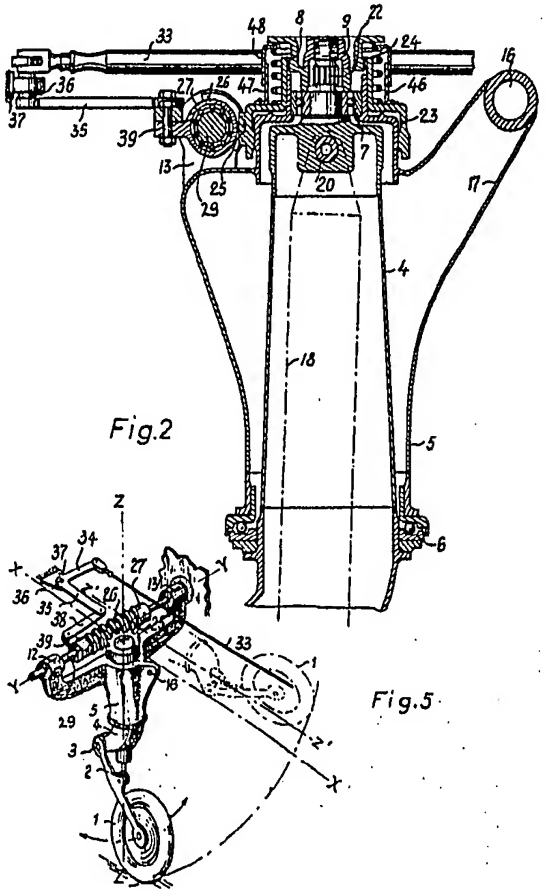


Fig.2




Fig.5

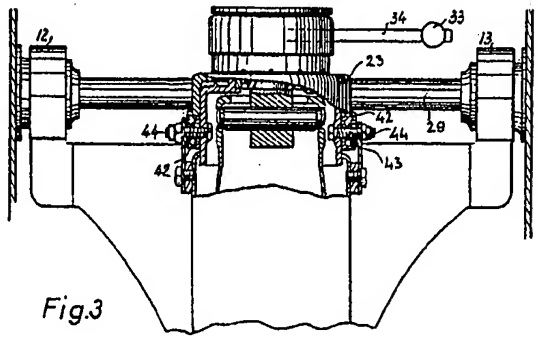


Fig.3

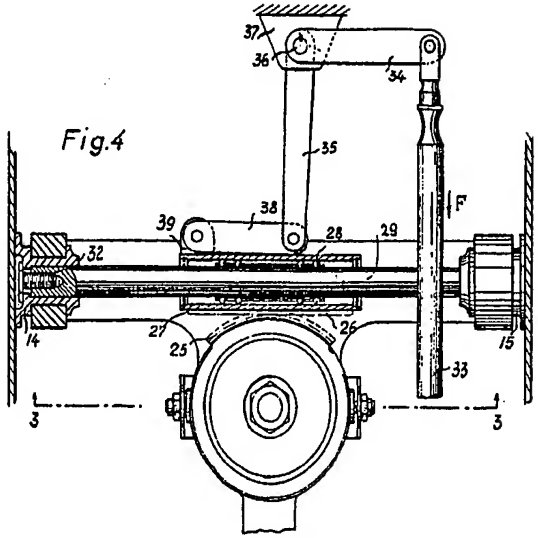


Fig.4